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AN ANALYSIS OF THE ADVANCED
TRACEABILITY AND CONTROL SYSTEM GOALS

by

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ABSTRACT

The purpose of this thesis is to analyze the efficiency and effèctiveness of the Advanced Traceability and Control System (ATAC). Prior to the implementation of ATAC, end users of depot level repairables sent retrograde carcasses to various organic and commercial facilities for repair and overhaul. Due to many factors, the depot level carcass tracking system was unable to prevent the loss or delay of many retrograde carcass's through the transportation pipeline. These problems resulted in erroneous charges to the type commander's operating funds, unnecessary investment in inventory levels to meet demand, and a possible lessened fleet readiness due to shortages for critical repair items. The Navy's solution to this problem is ATAC. The ATAC program simplifies the retrograde turn-in process while providing improved traceability and accountability throughout the return pipeline.

TABLE OF CONTENTS

I. INTRODUCTION

A. GENERAL

Repairables management in the Navy has become very important because of the change that has occurred in the type of material that the Navy's Inventory Control Points (ICPs) manage. With the increasing sophistication of weapons systems and their supporting platforms the Navy recognized the need to understand the relationship between logistic support and the design of the system. As a result of the understanding of the relationship between support and design, weapons systems are now being constructed in modules to facilitate repair.

The Navy supports the module design concept of its equipment by dividing the removable modules into three levels of repairables. They include field level repairables, which are those items that can be repaired at the organizational level; intermediate level repairables, those items that must be sent to a Tender or Shore Intermediate Maintenance Activity (IMA) for repair; and finally, depot level repairables (DLRs), those items that must be sent to a commercial or Navy Designated Overhaul Point (DOP) to return this item to a ready-for-issue (RFI) condition. This trend toward modularization/repairability reflects the Navy's policy to build more reliable systems.

Reliability, maintainability, availability, and supportability represent concepts by which the Navy attempts to meet numerous and often conflicting goals, not the least of which is what to buy, how much to buy, and when to buy it.

The Navy Supply System manages over 140,000 DLRs. Inventory investments of this magnitude require the highest management attention at all levels of the supply system to ensure that material is being used efficiently and effectively. The Navy's two inventory control points keep track of this critical segment of material by the use of several computer programs designed to monitor changes in inventory levels, condition, and locations.

On 1 November 1984 the Navy implemented a new policy of "Total Systems Carcass Tracking." The new procedures were designed to track the entire universe of DLRs managed by the ICPs and applied to all units regardless of automated carcass tracking capability. The stated purpose of this system was to reduce investments in repairable inventories by compressing carcass return times. To help accomplish this purpose Fleet Material Support Office (FMSO) developed the Repairables Management Data System (RMDS UM-B35) program to generate statistical reports to measure activity performance in the processing of DLR turn-ins. [Ref. 1:p. 1] The intent of the RMDS is to improve supply system performance for repairables in the following areas:

(1) increased asset visibility at commercial and organic repair facilities;
(2) reduction of depot repair cycle time by improved management techniques;
(3) reduction and justification of budget projections through the use of current repair prices, improved forecasts/scheduling and additional data visibility;
(4) monitoring/managing depot repair and repair funds by utilizing additional data elements and program capabilities;
(5) maximizing carcass returns by automated follow-ups;
(6) real-time updates of an on-line data base;
(7) interface with related functional areas to access/update new files. [Ref. 2:p. 2-1]

Despite the improvements made by the implementation of the new procedures of the Total Systems Carcass Tracking, a 1985 inspection of Naval Air Systems Command by the Naval Inspector General found,

> . . . Today's system gives poor visibility to DLRs in the pipeline and has very limited capability to trace or measure DLR movement. Physical distribution functions of receiving, storing, issuing, and shipping are paper bound and sluggish. (No logistics system can be any faster than its central control mechanism which, in our Navy, is run by paper requisitions, a method far too expensive and slow.) DLRs are frequently commingled with dissimilar cargo, resulting in repeated and unnecessary handling and routing. Frequently, NRFI (Not-Ready-For-Issue) DLRs in the pipeline are improperly packed and mismarked, creating the potential for damage, loss and derogation of inventory accuracy. [Ref. 3:p. 18]

Advanced Traceability and Control (ATAC) is a program designed to address these deficiencies.

B. PURPOSE

The purpose of this thesis is to assess the efficiency and effectiveness of the ATAC program with regard to the following questions:

1) What effect does the ATAC program have on the shipping time of DLRs from the end user to the hub (Naval Supply Depot at San Diego California and Norfolk Virginia, which provides; verification of drawing/part number to National Stock Number, NSN; document correction; Master Repairable Item List inquiry to determine overhaul point; Transaction Item Reporting and repacking for shipment/storage) and from the hub to the overhaul point?

2) Does ATAC reduce system inventory levels due to fewer parts in the repair pipeline?

3) How can ATAC be used more effectively from the perspective of the individual ship/type commander?

To help limit the subjectivity of the analysis of ATAC, it is felt that the measurement of effectiveness used in the study done by the Douglas Aircraft Company that was solicited by NASA will help focus the discussion around unbiased criteria. In the NASA study the Douglas Aircraft Company listed the different criteria that they felt were important in evaluating transportation trends and requirements for the 1990's. [Ref. 4] By applying the pertinent criteria from the Douglas Aircraft Company study to this analysis should reduce the effects of any personal bias held by the authors of this research or the people interviewed regarding this program. The analysis of the following criteria as they relate to the questions posed in this thesis will address the critical success factors germane to ATAC.

1. Shipment Tracing Capability

   a. Loss/Damage

   b. Information Services

2. Time-in-Transit

    a. Consistent, On-time Pickup and Delivery

    b. Points Served

3. Adaptability to Specific Needs

    a. Consolidation/Break Bulk Services

    b. Acceptance of All Sizes of Shipments [Ref. 5:p. 30]

The above criteria will provide both a useful analysis of activity indicators such as receipt processing time, system losses, resource requirements and enhancement of inventory accuracy while addressing the value that this information provides management. The following is a brief description of the criteria used in the analysis of ATAC.

Shipment tracing capability is critical to any performance analysis of ATAC. Knowledge of where the material is currently located provides inventory managers the flexibility to expedite and redistribute carcasses for repair or storage as needed. The traceability function allows the end user to challenge erroneous charges to his OPTAR (Operating Target, annual funds issued by a type commander to a cost center). This aspect should assure the end user of paying only for those items for which he is in fact responsible. The tracing capability will also provide management with the ability to analyze the route structure that retrograde material follows. This analysis of carcass returns can generate statistical reports to highlight

various activities involved with the turn in process to assess compliance with cost and performance objectives.

Time-in-transit is the total time from the removal of the failed DLR from the equipment to the time that the carcass is either put into storage awaiting repair (F condition storage) or inducted by the Designated Overhaul Point (DOP) for repair (M condition). This measurement of time is important because of its impact on the computation of repair turn around time (RTAT) and ultimately on the number of items to be purchased or repaired.

Adaptability to specific needs refers to the ability of ATAC to react to unplanned or non-schedule requirements. This point is of particular importance given the world-wide mission of the U.S. Navy. ATAC must be able to accommodate the changes in Navy requirements due to operational emergencies.

The goal of this thesis is to establish an accurate and meaningful measurement of effectiveness of the ATAC program. This analysis was difficult to quantify in some cases because of weak or non-existent data describing the transportation time frames concerning pre-ATAC retrograde turn-ins.

Chapter II of this thesis gives a brief background of the Navy Supply System and the history of ATAC. Chapter III covers the methodology used and a description of study design; data sources; sampling methods and extraction; and

description of inventory models. Chapter IV provides the analysis of data concerning carcass returns from the information we were able to extract from the Transaction History File using the FOCUS program from the two ICPs. Chapter V presents an analysis of how reductions in repair pipeline can reduce inventory investment. Finally, Chapter VI presents conclusions and recommendations.

This analysis compares pre-ATAC/post-ATAC retrograde turn-in procedures and establishes that ATAC is an effective use of resources given the value and the vital nature of the cargo being shipped. As will be brought out in the following chapters, the potential of ATAC to further integrate the Navy's supply system and improve management practices is immense.

II. HISTORY AND PURPOSE OF TURN-IN PROCESS

A. ICP BACKGROUND INFORMATION

The Navy's supply system is a part of the Department of Defense (DOD) supply and distribution system. Over the last thirty years DOD has used the technique of Integrated Management Policy to control its wholesale inventory. One of the major objectives of this policy stressed that the various military services, DLA, and GSA activities would operate their material management systems with the minimum number of items required to support their missions. The establishment of Inventory Control Points (ICP) for the management of organic material assured that systems support functions, supply management, and technical responsibilities were consistent with the individual services' objectives. [Ref. 6:p. II.1-1]

The elements of the Navy supply system include cataloging, identification, standardization, requirements determination, procurement, inspection and quality control, distribution and storage, contracting for repair of DLRs, disposal of material, mobilization/readiness planning, and finally, item classification.

The Navy maintains three levels of inventory based on the concept of wholesale/retail systems. These three levels of inventory are wholesale, intermediate/retail, and

consumer/retail. The wholesale level of inventory is defined as inventories over which an inventory manager exercises unrestricted control at the national level to meet worldwide responsibilities (regardless of funding source). These inventory managers perform their duties at the Navy's two ICPs, Ships Parts Control Center (SPCC) and Aviation Supply Office (ASO). Intermediate (retail) inventories are maintained for support of a defined geographic area or for tailored support of specific consumers (regardless of funding source). Generally, this material is held at a stock point (NSC/NSD). The consumer (retail) inventories are computed on an allowance list to meet specific readiness goals for a particular platform or system. These inventories are under the control of an end user and are issued directly to the maintenance personnel in support of that command's mission. These inventories are not used to resupply another level of stock. [Ref. 6:p. II.1-10]

The ICPs' main purpose in the Navy supply system is to manage the material directly under their cognizance. A secondary function that these two ICPs perform is the program support function. Program support deals with the equipment or weapon system, while the supply support functions entail item management, requirements of material (either procurement or repair), material distribution, and disposal.

The inventory manager/item manager is at the focal point for controlling and ensuring that adequate wholesale stock levels are available to support recurring and non-recurring demands. The item manager, through the use of computerized inventory models, forecasts stock requirements from many inputs. Some of the significant factors that will drive the level of inventory are the maintenance plan for the equipment, predicted or historical failure rates of the item, the maintenance codes for the item (lowest level of maintenance authorized to remove, repair and or replace the item), military essentiality of the item, and the relative cost and/or availability of funds. [Ref. 7]

The item manager is able to efficiently perform his duties because of the Uniform Automated Data Processing System (UADPS) which is a integral part of the Uniform Inventory Control Program (UICP). This highly sophisticated computerized system is designed to make decisions regarding the basic parameters of the Navy's inventory. The system is capable of making accurate decisions because the UICP maintains up-to-date and historical information on supply status for all the items over which the ICP has cognizance. The UICP inventory management operations include the Requisition Processing, Transaction Item Reporting (TIR), Cyclic Levels and Forecasting, Planned Program Requirements, Supply Demand Review, Cyclic Repair Management, Stratification, Disposal and a statistical package. The

value of the systems' decisions concerning inventory management is directly related to the accuracy of the data maintained in the UICP. The Application/Operation (program A/O, number C-10), or File Maintenance as it is sometimes called, is one of the more critical aspects of the item manager's responsibilities. The four major files in the UICP are the Master Data File (MDF), Repairables Management File (RMF), Planned Program Requirements File (PPF), and the Due-in/Due-out File (DDF). The basic method by which these files are kept current is by Transaction Item Reporting (TIR).

TIR allows the ICPs to record receipts, issues, and inventory adjustments on a daily basis into the MDF and various other files as required. The TIR allows the ICP through its various files and computer programs to access the necessary information to perform the following functions:

a. Establish, update, or validate records in the MDF

b. Records demands for RFI material, asset redistribution, repair inductions and disposals

c. Records carcass turn-ins and redistributions

d. Calculation of leadtimes, reorder point deficiencies, on-hand assets for backorder release

e. Follow-ups for overdue items in the DDF

f. Gains and losses by inventory. [Ref. 6:p. II.1-1]

All of the above aspects allow the UICP system to answer the key questions of what, when, or how much to buy and/or

repair. This answer is arrived at by first forecasting demand of the unit. Then, in the case of a repairable, the UICP forecasts the Repair Survival Rate, the percentage of carcasses that are returned to A condition, (RFI). With an estimate of the repair survival rate the UICP can forecast the average procurement requirements and repair turnaround times for each item. Also, the ICP must set the order, holding and repair costs, estimate economic order quantities for purchases and repairs, and finally, set stockout risks.

B. REPAIRABLES MANAGEMENT

Repairables management is the strategy by which the Navy centrally controls the return and repair of items that are less expensive and faster to repair than to purchase. The objective of this strategy is to support the Procurement Management strategy of reducing repair leadtimes and costs while improving quality. [Ref. 8:p. V-13]

As weapon systems have increased in complexity and design sophistication, the equipment and the components that make up that equipment have also become more complex and difficult to repair by the end user. One of the responses to the problem of effecting repair in the field was to design weapon systems so that entire modules or sub-assemblies with the defective/failed part would be replaced. Because these modules are usually very expensive and can have a long lead-time for procurement, the applicable Hardware Systems Command will designate the item as a

repairable. This designation is usually done during the system development stage of the maintenance plan for the equipment in question. It is the maintenance plan which will determine if the item will be a repairable or consumable. If it is a repairable item, then the maintenance plan will establish what level (field, intermediate and depot) the item can be repaired. This information is used to assign the Source, Maintenance and Recoverability (SM&R) code which will reflect the particular maintenance philosophy associated with a piece of equipment.

Other factors that must be considered when assigning a SM&R code are assembly costs, establishment of the repair pipeline costs, reliability of the item, and cost and technical expertise required to operate the equipment necessary to perform the repair.

Repairables Management has been and is a primary source of replenishment for Depot Level Repairables (DLR). [Ref. 6:p. II.1-1] Currently the ICPs coordinate repair policy between the Hardware System Commands, Type Commanders, DOPs and technical agencies to maximize the efficient use of limited DLR resources. [Ref. 8:p. V-13] The Navy's policy with regard to Material Turned Into Store (MTIS) procedures resulted from a 23 May 1978 presentation to the Chief Of Naval Operations (CNO) concerning both the procurement and repair of DLRs. From the CNO-directed study it was believed

that the following benefits would result from the stock funding of DLRs:

> 1) Improved supply system discipline resulting from the buyer-seller relationship inherent in a stock funded environment instead of the current "free-issue" procedure.
> 2) Improved financial flexibility due to the ability to trade-off procurement and repair dollars during budget execution.
> 3) Improved material support responsiveness due to the stock fund's ability to respond to emergent requirements in a more expeditious manner.
> 4) Improved budget forecasting due to shorter stock fund budget leadtimes. [Ref. 9:p. 2]

The new policy concerning DLRs would make carcass turn-in and tracking an integral part of the stock fund pricing and credit policy. Specifically the DLR monitoring system at the ICPs will generate statistics on carcass return rate thus identifying deficient areas with regard to carcass turn-in. It will also monitor DLR retrograde to identify and follow-up on overdue or missing carcasses. [Ref. 9:p. 4]

The ICPs responded to the increased emphasis given to the DLRs by dividing the items into smaller, more manageable categories. ASO broke their DLRs into three groups: high impact items (15 percent of the repairable population), medium impact (35 percent), and low impact (50 percent). [Ref. 10:p. 3-69] The high impact group was further broken down into the HI-BURNER and Intensive Closed Loop Aeronautical Management Program (I-CLAMP).

> HI-BURNER components are items not included in I-CLAMP with 25 or more demands per quarter, and/or annual repair cost of $80K or greater, or are specifically approved as special interest items by ASO and NALC. HI-BURNER

> requirements include anticipated quarterly demands, backorders, planned program requirements of all types, and safety level. Each quarter a Hi-BURNER worksheet is developed by each Weapon Manager forecasting repair requirements for each family group for the current quarter plus an additional three quarters. The repair schedule is constrained by carcass availability, both on hand and expected generations, and piece part availability. [Ref. 11:p. II-6]

The benefit of the HI-BURNER program is that the Navy Air Rework Facility (NARF) and the DOP are able to give more attention to the problems of piece part support and other work stoppage reasons. This increased management attention has resulted in a better allocation of manhours and funding through a more level scheduling of work at the rework facilities. [Ref. 6:p. II.2-57]

I-CLAMP rework requirements include anticipated quarterly demands, backorders, planned program requirements of all types and safety level. It provides intensive care to serious readiness degrading components through a hands-on scheduling process intended to focus management attention. The benefit of this program is that it allows the ICP to improve intermediate repair productivity by helping the organization of quarterly repair schedules and monitoring/expediting missing parts required to repair DLRs at the NARF. [Ref. 11]

SPCC developed the Fleet Intensified Repairables Management (FIRM) program. The original purpose of this program was to focus attention on fast moving, high failure, and/or other critical DLRs. These DLRs were identified for

weapons systems by management through a four digit code, called a Cog, and workloading conferences with the DOPs. [Ref. 11:p. II.2-59] FIRM accomplished this by establishing a system for expediting movement of the F condition asset from the user to the overhaul point. The basics of the FIRM program have been expanded to all SPCC DLRs.

The time horizon for the repair of the DLRs is more complicated due to the consideration of several more variables. Where DLRs are concerned, the

> Cyclic Repair Management (program A/O B08) was designed to help satisfy DLR system stock requirements for RFI units via the repair recommendation process for Navy or Commercial DOPs rather than through new procurement which is generally more costly and time consuming. . . . This system is processed weekly at ASO, and bi-weekly at SPCC. [Ref. 12:p. 2-1]

Generally speaking, the order of functions that the UICP must perform to ensure that the NRFI item is available to the system when and where it is needed are

> a. . . . compute system repair requirements by Urgency of Need Level . . . (general formula for this computation is System Gross Requirements minus System Net Serviceable Assets equals System Production Requirement)
>
> b. . . . DOP production/induction requirements and recommend scheduling actions.
>
> c. Upon completion of a and b above, produce statistical data for use in determining the repair scheduling actions to be processed automatically and those actions to be subject to manual review.
>
> d. Perform manual review.
>
> e. Update necessary files. [Ref. 12:p. 3-11]

Under constant operating conditions the item manager decision would be fairly easy, but considering that forecasted demands are primarily based on projected failure rates and planed operating tempos. Thus any fluctuation in these two variables can drastically alter demand for repair parts. Another complication in the forecasting process is the variable concerning regeneration of DLRs. The ICP must estimate the percentage of carcasses that will be repaired, (called repair survival rate) then determine if any material will have to be purchased to meet the expected demand.

So that the ICPs can be responsive to changes in the budget picture, the B08 program has to be flexible enough to allow for the suppression of automatically recommended repair actions. This option is made available to the item manager by Cognizance Symbol, Local Routing Code, Repair Funding Control Code, and Urgency of Need Level [Ref. 12:p. 3-21]. With this in mind it is easy to see why DLRs are considered more challenging to manage.

C. REPAIR CYCLE

SPCC's and ASO's repair cycles have significant differences, however, since these differences have little impact on the way ATAC interacts with the respective repair cycles, our discussion will investigate the repair cycle as the DLR enters the system as F condition material and goes through the Turn-in Process, Retrograde, Storage, Repair, and finally, return to RFI condition.

The repair cycle begins with the failure and subsequent requisition for the replacement DLR from supply. The end user is responsible for the proper turn-in of the item, and a double pricing system was established to help encourage the timely return of repairable material to the system. The standard price is the actual price that the end unit will pay if the carcass is not turned in, lost while in transit, or not capable of being repaired. The net price represents a significant savings to the end user, usually a third to one-half the standard price. The requisitioning activity will pay the net price if the carcass is properly turned in and is in a repairable condition. The difference in prices can amount to significant charges. COMNAVSURPAC estimates that $4.5 million of carcass charges will be charged to their end units' OPTAR in FY 87 [Ref. 13].

The key point to the Navy Stock Fund (NSF) pricing system is that the NSF will be able to recoup all costs associated with maintaining the supply system inventories. The success of the revolving NSF account is due in part to the buyer/seller relationship that encourages the timely return of material for repair.

The requisition, through the Material Condition Code (MCC) coupled with the correct cog and advice code, will key the supply system that a carcass should be entering the repair cycle. The UICP has an extensive tracking system to insure that a carcass does enter the retrograde pipeline and

then follows the DLR through the repair cycle until it is either returned to A condition, RFI, or turned into disposal.

The Master Repairable Item List (MRIL) is the primary source of information for turn-in of most repairables. Conventional ammunition, torpedoes, mines, and surface missiles are not covered by the MRIL. The MRIL contains the necessary information for the shipment of the DLR to the DOP or Designated Support Point (DSP). It provides the address of the DOP/DSP, Movement Priority Designator (MPD) code, any special instruction for packing or shipment of the carcass, security classification and when applicable, local disposal instructions.

The MPD is derived from the Maintenance/Overhaul Designator (MOD) which is a one digit code used to determine if carcass returns will be directly to a DOP, stock point or disposal. The use of these two codes ensures that the DLR is moved in accordance with system needs and in the most expeditious manner. [Ref. 12:p. 3-3]

Once the carcass reaches a reporting activity, generally a stock point, a TIR will be sent to the ICP. Historically this is the first point in the turn-in process that the ICP had visibility of the carcass. Stock points were selected to TIR material because they experienced personnel to screen the carcass to verify the information on the DD 1348-1 turn-in document. The time that took the first leg of

transporting the carcass to the DOP/DSP was about 17 days. If the carcass was coming out of the Mediterranean it could have taken as much as 36 days to reach the DOP/DSP [Ref. 14].

At this point in the repair cycle the carcass could go to the DOP for repair or into F condition storage. If the item is an ASO managed item, the DOP storage location may be co-located with the repair activity and the repair induction will be directed by the HI-BURNER, I-CLAMP or B08 (repair schedule) program. If the item is managed by SPCC, then the B08 program will recommend redistribution of NRFI material for future repair which will then be reviewed by the item manager.

If the carcass is inducted for repair at a Navy DOP, then daily TIRs will be sent to the ICP indicating that a quantity of material has moved into M condition (in repair). When the carcass is repaired the DOP will send a TIR reflecting the change to A condition. Until recently, if a carcass was inducted at a commercial DOP then TIR information between the ICP and the repair activity was sporadic or did not even exist. ASO and SPCC have recognized that this lack of visibility and accountability over rework performed by commercial vendors was unacceptable. A major portion of the visibility and accountability problem was solved by ASO by the addition of approximately 56 commercial vendors with TIR reporting

capability [Ref. 11:p. VI-11]. Interservice repair is performed under a Depot Maintenance Interservice Support Agreements (DMISAs) or Wholesale Interservice Supply Support Agreements (WISSAs). These repairs are entered into the ICPs' B08 program manually, so repair status information is not real time [Ref. 6:p. II.2-53.

D. PRE-ATAC REPAIRABLES TURN-IN PROCESS

Prior to the start up of ATAC each unit was responsible for identifying, packaging, and documenting of the carcass turn-in. Supply department personnel were required to research each turn-in to determine the proper destination and movement priority of the DLR by referring to the MRIL. For many reasons this turn-in procedure turned out to be slow and inefficient.

When a DLR unit failed, the work center performing the maintenance action would submit a NAVSUP Form 1250-1 requesting a replacement. If there was no remain-in-place requirement, the work center would turn in the failed item to supply department personnel with the 1250-1. The supply department would then either fill the requisition from stock or pass the requirement to the nearest stock point. If the requisition was filled from stock, normal supply procedures would generate a stock replenishment action to replace the issue of the DLR. At the same time, the failed (F condition) carcass would be packaged for shipment in accordance with current TYCOM procedures, NAVSUP P-485, and

the MRIL. A DD Form 1348-1 turn-in document would be prepared using the same document number used for the replenishment requisition. The significance in using the same document number on both the turn-in and the requisition is that the ICP maintains a Transaction History File (THF) of the requisitions by document number and attempts to match up carcass returns in the UICP with TIRs.

The supply department could use any one of a number of methods (if not prohibited in the MRIL) to send the carcass to the DOP/DSP. Carcasses could be returned via the normal Navy supply pipeline established to support deployed units or sent via the U.S. mail. The use of normal supply channels for return of carcasses was slow, with little or no controls in place to track material and establish accountability. There is no monetary incentive for any component of the transportation system to try to attain a particular level of efficiency in the movement of the DLRs back for repair. With inadequate procedures in place to trace DLRs in the retrograde pipeline, and reimbursements for lost carcasses being made to the Navy Stock Fund by the end users' OPTAR, it is easy to see how inefficiencies could exist.

Upon receipt of the carcass at the DOP/DSP, the material had to be screened to verify that the part number crossed to the National Stock Number (NSN), and that the quantity turned in matched what was stated on the turn-in document.

The duplication of the screening process at all the DOPs/DSPs was redundant and therefore inefficient. The entire MILSTRIP data would then be key punched into the system to generate a TIR (many commercial DOPs still do not have TIR capability). An error in the document number or quantity could cause the turn-in to be unmatched and thus require administrative follow up to resolve the discrepancy.

One of the bright spots of the pre-ATAC turn-in procedures was the Fleet Repairables Assistance Agents (FRAAs) that NAVSUP established to provide assistance in improving the overall retrograde process. The FRAA agents were tasked by NAVSUP to monitor the retrograde system and identify and correct any problems that they uncovered. They also assisted commands with the handling of repairables by providing training, pick up service, and packing material. All a command had to do to schedule these services was to call the FRAA and make an appointment. This feature alone greatly helped expedite the turn-in of material. The on-the-job training and packing material were extremely helpful for units that were about to deploy. The FRAA was another source of information about procedures for turning in material while deployed.

E. CURRENT PROCEDURES UNDER ATAC

In an attempt to further refine the DLR process, ATAC is designed to "improve supply response time, inventory accuracy, productivity and performance in the physical

distribution functions of issuing, receiving, shipping and transportation" [Ref. 15:p. 16]. In accordance with the OMB directive A-76, many functions formerly performed by the military have been turned over to civilian contractors. The civilian contractors that were originally hired to implement ATAC were Burlington Northern (BN) and Emery. For reasons that go beyond the scope of this thesis the second services contract for the performance of the ATAC function was awarded to Morrison-Knudson Engineers, Inc., (MKE).

Under the auspices of the Naval Material Transportation Office (NAVMTO) the ATAC system through BN, Emery, and MKE has made significant changes to the organization's handling the physical movement of the carcasses and the end user DLR turn in procedures.

Procedures at the various ATAC sites will vary due to the different functional requirements of the facility. It is easy to see that there would be vastly different requirements at a naval air station located hundreds of miles inland as opposed to a naval port. Generally speaking, the F condition pipeline begins with the failure of the DLR and the requisition for a replacement. The end user is responsible for the turn-in of the carcass and must promptly follow up on administrative inquiry concerning its status.

ATAC is a program that combines the function of a commercial freight agent and a centralized Navy DLR

technical screening process to ensure traceability/ accountability over the movement of thousands of carcasses by the use of a computerized, bar code retrograde system. The freight agent receives intransit shipments of DLR carcasses from various sites/activities around the world. The carcass can be turned in directly to a Node (usually a stock point acting as a collection, consolidation and trans-shipment point) or given to a MLSF, carrier/tender, or remote shore station for transshipment to a Node. The freight agent will consolidate material for transshipment to the Hub, either the Naval Supply Center at Norfolk or San Diego. The concentration of the functions of technical screening and then generating a TIR on 100 percent of the carcasses in the retrograde pipeline gives ATAC an advantage in cost and timeliness over the old retrograde process. The carcass with the bar code labels will then be shipped in accordance with the MRIL. Also, the potential exists for the improvement in the redistribution of F condition material because the actual sorting of the carcass is now being done at the Hub via an automated MRIL. If for any reason the ICP wishes to change the MPD or destination of the DLR, it can change the address in the automated MRIL. Under the old method of turn-in the end user had to consult the MRIL, which was updated quarterly on microfiche.

The technical screening process is very important because it ensures that the information on the turn-in

document matches the item actually being returned. It is also vital that the DLR is identified to the correct NSN and manufacturer's code. Any incorrect information will be corrected and a Report of Discrepancy (ROD) will be prepared. A bar code label will be produced and attached to the carcass. A TIR will then be generated, passing the appropriate information to the ICP. [Ref. 16]

The TIR serves two purposes; first, it signals the ICP to allow the end user to pay the net price and secondly, it alerts the item manager to the fact that NRFI material is available for induction into the repair cycle. Another benefit of the ATAC program is that all carcasses will have TIRs generated by the Hub. This gives the item manager quicker visibility of the NRFI, item thereby providing management with more accurate and timely inventory status. This quicker visibility can reduce administrative follow up actions necessary to track carcasses that do not appear in the system with in the established timeframes.

Specific statements of work (SOWs) for various naval activities have been written and are tailored to reflect the unique needs of that area. A brief synopsis of the general functions that are required of the contractor are:

1. Receive DLRs from site activities; unpack outer container, apply a bar code label to each line item and stage the material for receipt/induction into screening process.

2. Consolidate and deliver DLRs to HUB and DOPs/DSPs.

3. Provide proof of receipt to site activity (end user).

4. Provide protective packing and re-cooperage services for intransit shipments so that the DLRs will not sustain damage during consolidated pack transportation to the Hub. In most cases the DLRs will be packed prior to release to agent. If not, the agent will request assistance from the co-located supply activity.

5. Prepare appropriate documentation and ship via the mode and carrier prescribed by Navy Material Transportation Office (NAVMTO) to the screening Hub.

6. Complete the services in 1 through 5 above on the same day of the pick up of the DLRs unless other arrangements are specified at a designated site.

7. Pick up DLRs from ships at pierside and other specified locations and deliver to the Hub.

8. Receive screened DLRs from Government personnel at the Hub and provide proof of receipt.

9. Within 24-hours of receipt, prepare appropriate documentation, consolidate shipments to the maximum extent for each destination using the most economical container for the mode utilized and ship for the Hub by the prescribed mode or carrier to the appropriate DOP/DSP. When transportation is arranged by the agent, the DLR must reach final destination no later than the second business day after shipment from the Hub unless otherwise directed by the Government.

10. Provide to NAVMTO comprehensive information about each DLR line item in the ATAC system.

11. Maintain a comprehensive tracing system which will provide Proof Of Shipment (POS) and Proof Of Delivery (POD), including daily updates, in an on line, real time data base. Telephone or message requests for information will be answered within four business hours.

12. Coordinate with local support activity to arrange for them to package and certify any hazardous shipments.

13. At some locations, when necessary, issue Transportation Discrepancy Reports.

14. Prepare a weekly transshipment report for the Hub on a magnetic tape per Statement Of Work (SOW). [Ref. 17]

The following is a synopsis of what the Government will provide to the contractor in support of the ATAC contract.

1. Ensure Government Bills of Lading (GBLs) are properly filled out and executed for commercial shipments.

2. Supply Agent with skeletonized Government documents, instructions and regulations that are necessary for the successful transshipment of cargo by military terminals.

3. Authorize the movement of Navy cargo by air; challenge the validity of airlift requirements in accordance with Naval Supply Systems Command directives; divert material to lower cost modes, as necessary, to control the expenditure of Navy funds.

4. Provide administrative direction for payment review, documentation processing, and cost comparison analysis (commercial air vs military air).

5. Provide Agent with guidance as to Navy priorities and deadlines.

6. Provide Agent with advice and guidelines as needed to further define changing day to day requirements.

7. Screen all material against the MRIL for correct identification, documentation, and packaging and to confirm the correct distribution to DOP/DSP.

8. Provide at building SP 237, NSC Norfolk floor space with an area 35 feet by 80 feet if the Agent desires to establish an office or put in any reasonable structure at the Agent's expense. The Government will also provide a small area at NSC Jacksonville, NSC Pensacola, and NSC Charleston.

9. Provide the Agent with a manifest of all DLRs showing Requisition Number, Consignee UIC, NIIN, TCN, pieces and weight for shipments outbound from the Hub. [Ref. 17]

The ATAC system will not be used to transport carcasses from the end user to intermediate level maintenance for repair. Other items that are excluded from the ATAC program are:

1. Aircraft engines

2. Marine gas turbine engines

3. Fleet ballistic missile components

4. Classified items

5. All material coded for disposal

6. Engineering Investigation (EI)/Quality Deficiency Report (QDR) material destined for a location other than the Norfolk/San Diego area

7. Redistributions

8. Nuclear reactor plant material (SMIC of X1, X2, X3, X4, and X5)

9. Radiac equipment

10. Hazardous/flammable items (if not properly packaged with Federal regulations and NAVSUP P505). [Ref. 16:p. 5]

The terms of this Statement of Requirements state that:

a. This agreement may be modified to add or delete receiving and processing sites, or to change the specifications for processing of the intransit shipments upon a minimum of 30 days notice, or earlier if agreed to by the Agent and the Navy.

b. This agreement may be terminated by either party upon written notice of not less than 90 days.

c. In accepting this agreement, selected agent acknowledges that Navy supplied work load volumes are best estimates and agrees to hold the Navy harmless for estimates made in good faith, based on data available at the time of negotiation. [Ref. 17]

As for Liability:

> The Agent shall assume liability of $9.07 per pound for any and all lost or damaged Government material covered by this agreement except when such loss or damage arises out of causes beyond the control of and without the fault or negligence of the Agent. . . . but in every case the loss or damage must be beyond the control of, and without the fault or negligence of the Agent. . . . The Agent shall

protect material in his custody against transportation and weather hazards. [Ref. 17:p. 11]

The rate that is charged by the contractor is assessed on the basis of line items processed. A line item is considered to be complete when there is a proof of delivery from the DOP or the item is stowed/disposed of at the Hub. The passage of 30 days form initial entry of the carcass with proof of shipment or transfer to the government will also complete the transaction with regard to payment. The contractor will provide a breakdown of the charges based on specific site functions to be performed prior to commencement of work. The actual rates that were bid on the performance were based on line item estimates at each site. If the quantity of line items varies more than 20% a month for three months above or below the estimate the rate charges can be renegotiated [Ref. 17].

III. METHODOLOGY

A. DESCRIPTION OF STUDY DESIGN

The goals of ATAC are "the reduction of customer response time, retrograde time, receipt processing time, system losses, resource requirements and enhancement of inventory accuracy" [Ref.15:p.16]. ATAC attempts to correct the previously discussed weaknesses of the carcass turn-in pipeline by reorganizing the transportation network and establishing a new management information system to track carcass turn-ins.

To assess ATAC's success in obtaining these goals, some measures of effectiveness (MOE) are required that would contrast comparable parameters obtained from historical records that existed prior to the ATAC implementation and the current data base that now exists. To determine whether ATAC has fulfilled all of its aims is not yet possible; because there is no measure of effectiveness established that can be compared and the program is too new to provide a clear view of any possible change in performance.

The goals of this thesis were limited to answering the following research questions:

1. Does ATAC shorten the shipping time of DLR's from end user to overhaul point?
2. Does ATAC reduce system inventory levels due to fewer parts in the repair pipeline?

3. How can ATAC be used more effectively from the perspective of the individual type commander?

Limitations of scope, measures of effectiveness, and assumptions are described in this chapter for each research question. Additionally, a description of the inventory models used at the ICP'S is included in Chapter V to answer research question two. Finally, suggestions for future system growth are made in Chapter VI to deal with research question three.

B. MEASURES OF EFFECTIVENESS, LIMITATIONS OF SCOPE, AND ASSUMPTIONS

Research question one deals with the most concrete measure of effectiveness: the shipping time required to return a DLR carcass from the end user to the DOP/DSP. Retrograde shipping time is a surrogate measure of effectiveness for this process and is made up of distinct phases that can only be measured in the aggregate. Included in this measure is the amount of time the individual unit takes to prepare the DLR carcass for turn-in, the time required for the different legs of the transportation system to move the carcass, and the time spent handling, screening, and reporting the turn-in of the carcass by the TIR facilities. An attempt has been made with ATAC to improve performance in all three areas: the end user has more simplified turn-in procedures to follow under ATAC, the transportation network is designed to move material more quickly by use of a civilian contractor to handle and

tranship DLR carcasses, and improvements have been made to speed the flow of material through the TIR facilities at each hub.

The use of retrograde shipping time as a measure of performance is limited due to the fact that it is an aggregate measure and includes a segment of time that ATAC does not directly control (the speed of the end user turning in carcasses). However, the ATAC data base maintained to perform the tracking requirements can be used to measure the end user's performance in turning in DLR carcasses. This measurement process will be discussed later in this chapter with regard to research question three. Retrograde shipping time will be the measure of effectiveness for research question one. Information for this MOE is readily available for both pre-ATAC and post-ATAC timeframes.

In order to determine whether or not the implementation of ATAC has changed the time required for a DLR carcass to return to the DOP/DSP, this thesis will compare carcass return times of sample populations of documents from both pre-ATAC and post-ATAC timeframes. The following assumptions will be made:

1. The pre-ATAC timeframe under study is 1 June to 31 December 1985, (julian date 5151 - 5365);

2. Since the San Diego hub became operational 11 June 1986, the post-ATAC timeframe is 11 June to 31 December 1986, (julian date 6162 - 6365);

3. Sample DLR requisitions with matching turn-in documents from specific units (Unit Identification

Codes or UIC's) will be drawn from populations of both timeframes;

4. The specific units chosen will have similar deployment statuses during both the pre-ATAC and post-ATAC timeframes; if not, retrograde times for local operations and in port periods will be assumed to take less time than retrograde times during deployed periods because of reductions in transportation requirements;

5. The retrograde times for both timeframes will be the julian date of the TIR (D6A, D7A, BTR, ZAO) submission less the julian date of either the BC1 turn-in document or, if that is not available, the julian date of the document number;

6. Sample documents will be obtained from ASO and SPCC for both timeframes.

Research question two deals with the impact of ATAC on inventory investment levels of DLR items managed at the ICP level. Intuitively, one knows that if fewer items are sitting in the transportation pipeline, a smaller quantity of the items can be held in inventory to support the same user demand requirements. The MOE that this thesis examines is the number of items required to be held in inventory to support demand when there is a change upward or downward in the carcass retrograde time and the resulting savings in procurement, holding, and ordering costs.

Assumptions that are made in working with the inventory analysis include:

1. Reductions or increases in the observed retrograde times from pre- to post-ATAC is attributable to changes in the performance of the retrograde pipeline organizations;

2. Any changes in the observed retrograde times would be entered into the UICP inventory algorithms;

3. Changes in inventory levels would only be attributable to the change in retrograde time; any changes in inventory losses in the transportation system would be ignored;

4. Further assumptions dealing with the inventory models are explained later in Chapter V.

There are limitations on using changes in inventory levels as an MOE since inventory investment decisions are not based solely on DLR carcass retrograde times. Many of the parameters that are used in the UICP inventory models are based on forecasts or hypothetical information and can be updated at the ICP to reflect the command's current policies.

Research question three deals with how improvements to the ATAC system will allow individual type commanders and subordinate commands to more effectively manage their activities' turn-in performances and track DLR carcasses from the end user through the ATAC system to the overhaul point. The analysis of this research area centered around information provided by Morrison-Knudsen Engineers, Inc. (MKE) and on the personal observations and interviews conducted with Navy personnel and civilian contractors at NAVSUP, the ICPs, NAVMTO Norfolk, Virginia and Oakland, California, the hubs in Norfolk, Virginia and in San Diego, California, and the node in Oakland, California. Improvements are suggested that can be implemented with the existing technology and organization, and that should be

incorporated in the future as new innovations are introduced in the fleet and in transportation systems.

C. DATA SOURCES AND ACQUISITION

The data for this thesis was extracted from personal interviews, computer models, the transaction history files (THF) at the ICPs, and computerized shipping records maintained by MKE, the present ATAC civilian contractor. Background information on the operation of transportation systems, UICP inventory models, and other topics were provided by archival research and current readings of both Navy and civilian transportation publications.

D. DATA SAMPLING METHODS AND EXTRACTION

To determine the answer to research question one (i.e., has any change occurred in the DLR carcass retrograde time due to ATAC), data had to be examined from both a pre-ATAC and post-ATAC timeframe. The UICP application B35 is the Navy's baseline carcass tracking management information system which performs the following functions:

1. Processing and storing repair transactions;
2. Monitoring/tracking the status of retrograde actions, carcasses, and modifications;
3. Computing repair cycle time and observations, average repair costs, and survival rates;
4. Providing information via real-time retrievals;
5. Maintaining Depot Level Repairable (DLR) suspense records; and

6. Generating follow-ups, billing transactions, reports and statistics. [Ref.18]

The B35 program attempts to match incoming carcass TIRs from reporting activities with requisition documents, and continues to track the returned carcass through the initial TIR facility to either the F condition storage site or the DOP/DSP. After the receipt TIR is received by the ICP from one of these two locations, the carcass is no longer linked to the unit that turned it in. This carcass tracking transaction is purged from the B35 program and placed in the UICP THF.

After discussing the possibility of determining any change in the carcass retrograde time, Dave Estep, NAVSUP Code SUP 063A1 and ATAC program manager, noted that both ICPs maintained staffs dedicated to tracking the turn-in of DLR carcasses via application B35. LT Mary Giles and Tony Galen of ASO Code WPR1-A, Sue Holtzinger, SPCC Code 03511, and Pat Corica, SPCC Code 04211, were contacted to assist efforts in determining carcass return time by accessing the THF for completed carcass tracking transactions for both a pre-ATAC and post-ATAC timeframes. Both ICPs could access the THF via FOCUS, a UICP user language, and extract requested data in formats different from the normal UICP application's reports.

The main goal in collecting data was to obtain a representative and unbiased sample. In order to achieve this goal, the pre-ATAC timeframe was limited to a six month

period from 1 June 1985 to 31 December 1985. The three UICs submitting the most requisitions to ASO from each coast were the only carcass matches to be extracted from the THF, since the biggest customers of aviation related DLRs are shore commands and their retrograde times are unaffected by changes in deployment status.

The problem was approached from a different perspective for customers of SPCC. SPCC data can be distorted because the major customers are the Naval Shipyards, Shore Intermediate Maintenance Activities (SIMAs) and other overhaul activities. This is because requisitions from these activities are often ordered long in advance of actual usage and are coded with a remain in place advice code "5G". The turn-in of the carcass is delayed until the specified ship enters the overhaul activity and the work is performed. Although requisitions from overhaul activities were part of the study (and requisitions with advice code 5G deleted), other afloat UICs were specifically requested so that the impact of ATAC on ships from both coasts could be studied.

For consistency, the performance of both the Norfolk and San Diego hubs were to be included in the post-ATAC timeframe; the Norfolk hub became operation on 1 January 1986 and the San Diego hub commenced operation 11 June 1986. To include both hubs in the post-ATAC time period, requisitions that were submitted (by the same UICs as the pre-ATAC sample) between 11 June 1986 and 31 December 1986

with matching TIRs were requested to complete the carcass tracking transaction.

The areas of interest for each carcass match were the document number julian date, the julian date of the carcass turn-in document (BC1) for initial matching of the DLR carcass turn-in with the carcass suspense file and the TIR submission julian date. By subtracting the julian date of the TIR from the julian date of the BC1 document, a fair representation of the number of days required for the DLR carcass to move from the end user through the transportation network onward to the DOP/DSP could be obtained. For documents where no BC1 document julian date was available, the julian date of the requisition number was used.

Both ASO and SPCC were able to provide the requested data in a readily usable, though differing format. The request for data from ASO in July 1987 created problems for Code WRP-4A because a purge of old carcass matches from the THF active memory to tape storage had occurred just weeks before the thesis research visit. Nevertheless, the THF printout from ASO was very useful. For both timeframes, matched carcass tracking transactions were listed including requisition number, BC1 julian date (if available), TIR (D6A, D7A, BTR, or ZAO document identifiers used for different types of requisitions) julian date, and the TIR (D6K) julian date for the same six UICs from each timeframe. The FOCUS system programmer had the UICP program application

subtract the BC1 julian date from the TIR julian date to obtain the number of days required for the carcass to move from the end user to the screening TIR activity. Additionally, the program subtracted the julian date of the sending activity's TIR (document identifier D6A) from the receiving activity's TIR (document identifier D7K) to obtain the number of days required to move the carcass from the screening TIR activity to the DOP/DSP.

The same information was requested from SPCC. Both the number of days to move the carcass from the end user to the TIR facility and the number of days to move it from the TIR facility to the ultimate DOP/DSP was desired to be able to have comparable data from both ICPs. The THF printouts received from SPCC had the document number julian date and the julian date of the TIR. The FOCUS programmer had also subtracted the julian date of the document number from the TIR so that the number of observed turn-in days were easily obtained. A second printout was also received from SPCC with the same requested UIC's matched turn-in documents presenting the transhipment days from TIR facility to DOP/DSP (i.e., document identifier D6K minus document identifier D7K), but fewer than a dozen observations were displayed on the fifty plus pages of output (over 2800 observations). Pat Corica, SPCC Code 04211, said that the reason for so few entries was that the SPCC B35 program application did not track the second leg of transportation

of DLR carcasses from the TIR facility to the DOP/DSP until recent changes had been made due to resystemization of the computer hardware at the ICP.

Once the carcass turn-in data was extracted from the ICP transaction history files, the observed days of both legs of carcass transportation were entered into a personal computer for statistical analysis performed by a commercially available software package called "STATWORKS". The results of the statistical analysis of both the pre-ATAC and post-ATAC timeframes are presented with discussion in Chapter IV, and further details are presented in Appendix A.

The answer to research question three (i.e., how can ATAC be used more effectively from the perspective of the individual ship/type commander?) deals with the most subjective measure of effectiveness in this study. This question was approached from the perspective of the users of ATAC. First, the data base that is required to be maintained by the ATAC contractor (MKE), was reviewed to determine the time it takes for a carcass to leave the end user and arrive at a node. The starting point for this timeframe was the julian date of the document number to the calendar date that MKE receives the carcass at the node. The date from the document number was selected as the starting point for this measurement because MKE records this document number to enable them to track carcasses. It is

understood that this measurement only estimates the actual transit time from the end user to the node.

The computation of the estimates for the activities listed at the beginning of Chapter IV was made by subtracting the julian date from the DLR requisition document number from the calendar date that MKE signs for receipt of the carcass at the node. MKE produced the data for this research by manually printing each screen in their Materials Management System ATAC file while in the browse mode. Since the extraction and computation of this data had to be performed in a tedious and time consuming manner, only the most recent data available at the Norfolk office of MKE was reviewed.

The results of this inquiry is presented in Chapter IV and is not intended to be interpreted as representative of the overall performance of these activities or the Navy in general. This information demonstrates the value of gathering this type of pulse point information. Type commands can now easily monitor their activities to insure that performance is within set standards.

IV. ATAC IMPACT ON CARCASS RETURN TIME

A. ANALYSIS OF CARCASS RETURNS

This chapter will present an analysis of carcass return times for both pre-ATAC and post-ATAC timeframes for specific end-users. The data presented came from both the Aviation Supply Office (ASO) and Ship's Parts Control Center (SPCC) transaction history files for items managed by that ICP.

Data provided by ASO consisted of the three commands from each coast submitting the most DLR requisitions during the post-ATAC timeframe. SPCC provided carcass turn-in data for five commands from both timeframes. Data were received for the following commands:

UIC	Command Title
V09114	Marine Air Group 14 Marine Corps Air Station Cherry Point, North Carolina
N60200	Naval Air Station Cecil Field Jacksonville, Florida
N00246	Naval Air Station North Island San Diego, California
N60191	Naval Air Station Oceana Norfolk, Virginia
N60259	Naval Air Station Miramar, California
R57082	Marine Air Group Thirteen Marine Corps Air Station El Toro, California

UIC	Command Title
R21295	USS Vincennes (CG-49) Homeport: San Diego, California
R20807	USS Arkansas (CGN-41) Homeport: Alameda, California
R65918	Shore Intermediate Maintenance Activity San Diego, California
V32770	Shore Intermediate Maintenance Activity Norfolk, Virginia
N00253	Naval Undersea Warfare Engineering Station Keyport, Washington

After receipt of the turn-in data from the ICPs, the specific commands were checked against the ATAC implementation schedule provided by NAVSUP to ensure that the command was participating in ATAC in the post-ATAC timeframe of 11 June 1986 to 31 December 1986. This verification proved to be valuable as four of the commands provided by ASO were not yet participating in the ATAC transportation network in the post-ATAC timeframe designated by this thesis. The specific UICs that did not participate were N00246, N60191, and R57082 and the data provided for the commands were scheduled from the analysis of turn-in times.

Tables I and II below provide the summary of data for Marine Air Group 14. Table I displays the average number of days required for the first leg of the DLR carcass turn-in

from end user to the TIR activity (BC1 days) which is computed as the TIR julian date minus the BC1 document julian date or, if that is missing, the requisition number julian date. Table II displays the average number of days required for the second leg of the DLR carcass turn-in from the TIR activity to the DOP/DSP (BC2 days) which is computed as the D6K julian date minus the D7K julian date.

TABLE I

UIC V09114/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	15.887	20.243
MEDIAN	10.000	11.500
STANDARD DEVIATION	25.398	34.395
SAMPLE SIZE	53	74
RANGE	0-173	0-267

From Table I it appears that ATAC has had a negative influence on the time required to return a carcass from the end user to the TIR activity. In an attempt to reconcile this finding with expectations, Dave Estep, NAVSUP Code 063A1, was interviewed. He stated that although Marine Corps Air Station Cherry Point (where MAG 14 is stationed) is under the ATAC umbrella, the turn-in procedures there have changed little. The local supply activity at Cherry Point had submitted TIRs for carcass turn-ins prior to ATAC

implementation and had continued doing so after the transition. Presently, the DLR carcasses coming from the air station are turned in to the same supply activity and TIRs are submitted in the same way as pre-ATAC. After TIR submission, carcasses are then handled by the ATAC contractor for transshipment on to the DOP/DSP. It is therefore not surprising then to observe no improvement in the carcass turn-in time for this command if the retrograde pipeline procedures have remained practically the same.

TABLE II

UIC V09114/BC2 DAYS

	PRE-ATAC	POST-ATAC
MEAN	15.491	19.973
MEDIAN	13.000	18.000
STANDARD DEVIATION	12.361	12.315
SAMPLE SIZE	53	74
RANGE	1-88	0-64

As with the previous example, from this analysis it appears that ATAC has not improved the time required for the movement of DLR carcasses from the TIR activity at Cherry Point to the DOP/DSP. Since the turn-in organization has remained the same at this site, the increase in second leg turn-in time may be explained by factors occurring at the local supply activity.

Tables III and IV below present the same information for the other valid command participating in ATAC (data provided by ASO).

TABLE III

UIC N60200/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	8.877	27.485
MEDIAN	4.500	19.000
STANDARD DEVIATION	26.104	23.836
SAMPLE SIZE	358	1850
RANGE	0-398	5-244

From Table III it appears that the time required for the first transportation leg for material from NAS Cecil Field has been significantly lengthened by the switch to ATAC. There are several possible causative factors for this apparent increase. Under ATAC, all material originating from Jacksonville, Florida is received at the local ATAC node and transshipped onward to the Norfolk ATAC hub for screening and TIR submission. This extra step in handling could conceivably add two to five days onto the retrograde time. Additionally, during the designated post-ATAC timeframe, the Norfolk hub experienced a backlog of DLR carcasses awaiting contractor handling and government screening and TIR submission. During this time, arriving

DLR carcasses were experiencing an estimated 2-3 week delay in receipt, screening, and TIR submission [Ref. 3]. This is an area that could be reexamined after ATAC has operated for a sufficient time to overcome the initial "bugs."

TABLE IV

UIC N60200/BC2 DAYS

	PRE-ATAC	POST-ATAC
MEAN	15.774	13.582
MEDIAN	12.000	11.000
STANDARD DEVIATION	39.089	11.913
SAMPLE SIZE	358	1850
RANGE	1-711	1-241

For the first time it appears that ATAC has decreased the amount of time required to return a DLR carcass through the second leg of the transportation pipeline. The mean is reduced by two days and the standard deviation is much less. Taken with the reduction in the range, the sample data are much more tightly grouped and show meaningful decreases in carcass turn-in times from NAS Cecil Field.

The following tables display data received from SPCC and reflect only the first leg of the transportation pipeline from end user to the TIR facility (BC1 days).

Table V shows the results of turn-in data analysis from USS Vincennes (CG 49). USS Vincennes was employed during

the pre-ATAC timeframe in either local operations or inport periods. During the post-ATAC timeframe, USS Vincennes was employed doing local operations from 11 June to 11 August 1986 and then deployed to the Western Pacific area on 12 August 1986. [Ref. 18]

TABLE V

UIC R21295/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	61.893	40.525
MEDIAN	29.500	32.000
STANDARD DEVIATION	94.179	47.221
SAMPLE SIZE	84	177
RANGE	2-525	2-311

Here is the first sizable reduction observed in DLR carcass turn-in time. Even though the unit was deployed for the majority of the post-ATAC timeframe, there is a three week reduction in the mean retrograde time. Further, the standard deviation is reduced by half, meaning that the sample observations analyzed from the post-ATAC period are much more tightly grouped around the mean.

Table VI is the comparison done on the retrograde times of the USS Arkansas (CGN 41). As with the USS Vincennes, the USS Arkansas was inport or was employed on local operations during the pre-ATAC timeframe. The ship deployed

11 June to 8 August 1986 and returned to homeport 9 August 1986 and remained employed on local operations and inport upkeep periods for the remainder of 1986 and the post-ATAC timeframe [Ref. 18].

TABLE VI

UIC R20807/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	75.127	31.177
MEDIAN	38.000	25.500
STANDARD DEVIATION	81.712	28.639
SAMPLE SIZE	55	62
RANGE	7-433	7-186

The USS Arkansas also shows drastic reductions in DLR carcass retrograde time. The mean turn-in time is reduced over six weeks and the post-ATAC standard deviation is reduced to one-third of the pre-ATAC figure.

Table VII is the comparison of turn-in times for the Shore Intermediate Maintenance Activity (SIMA), San Diego, California.

SIMA San Diego, California also shows a reduction in the mean turn-in time of about a week. As before, the standard deviation of the post-ATAC timeframe is much less than the pre-ATAC amount, indicating less variability in the turn-in time for this command.

TABLE VII

UIC R65918/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	51.088	44.413
MEDIAN	28.000	31.000
STANDARD DEVIATION	60.437	40.245
SAMPLE SIZE	205	259
RANGE	7-445	10-226

Table VIII is the analysis of data for SIMA Norfolk, Virginia.

TABLE VIII

UIC V32770/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	75.000	38.125
MEDIAN	40.500	33.500
STANDARD DEVIATION	105.69	21.315
SAMPLE SIZE	12	40
RANGE	8-391	15-107

SIMA Norfolk, Virginia also shows a drastic reduction in both the mean turn-in time and the standard deviation of the sample data. This finding may not be significant due to the small amount of observations compared from the two periods.

Table IX is the final analysis of data and is a sample of turn-in times from Naval Undersea Warfare Engineering Station, Keyport, Washington.

TABLE IX

UIC N00253/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	36.859	16.632
MEDIAN	18.000	9.000
STANDARD DEVIATION	44.857	27.023
SAMPLE SIZE	1009	1938
RANGE	0-387	0-433

This command had nearly a three week reduction in the mean turn-in time during the post-ATAC timeframe. Additionally, the standard deviation was again much smaller, indicating a closer grouping of the sample observations during the post-ATAC period.

Table X displays both the pre- and post-ATAC means for the entire data sample from all valid end users. The mean retrograde time for the post-ATAC timeframe shows a ten day reduction for the first leg of the turn-in pipeline.

An SPCC study performed by Code 0132P also showed a decrease in the carcass return time starting as early as August 1986. Similar to this thesis, the study reviewed and compared the turn-in times from two months, January and

TABLE X

TOTAL SAMPLE SIZE/BC1 DAYS

	PRE-ATAC	POST-ATAC
MEAN	34.862	24.253
SAMPLE SIZE	1776	4400
RANGE	0-525	0-433

August 1986. No statistical analysis was done; the study used the FOCUS program to probe the transaction history file. Issue records from the carcass tracking files of application B35 were segregated into groups based on the number of observed days of carcass retrograde time. In the short time that ATAC had been implemented there had been noticeable improvements in the reported carcass retrograde times by August 1986. As shown in Table XI, almost 24 percent of the turn-ins reported in August 1986 had occurred within ten days of the requisition document julian date. In January 1986, no documents had turn-ins within that initial ten day period. The median observed days also decreased one full interval from the 30-39 day interval to the 20-29 day interval. [Ref. 19]

It is clear from both this research and the SPCC study that the DLR carcass retrograde time has decreased from pre-ATAC norms. The answer to research question one based on this analysis is certain: ATAC has shortened the mean shipping time of DLRs in the retrograde pipeline.

TABLE XI

COMPARISON OF SPCC CARCASS TRACKING RECORDS

NUMBER OF DAYS	AUGUST 1986 NUMBER OF RECORDS	%	JANUARY 1986 NUMBER OF RECORDS	%
0-9	47,534	24	0	0
10-19	28,527	14	14,876	18
20-29	28,907	14	14,008	17
30-39	20,116	10	10,239	13
40-49	14,249	7	7,404	9
50-59	9,670	5	4,860	6
60-69	7,008	4	3,573	4
70-79	12,329	6	6,232	8
100-119	4,750	2	2,712	3
>120	27,081	14	17,390	21
TOTAL	200,171	100	81,294	100

Source: [Ref. 19]

B. END USERS PERFORMANCE ANALYSIS

This part of the analysis of the carcass return times will focus exclusively on the time it takes a failed DLR to leave the end user and be received by the ATAC contractor at the node. Until the implementation of ATAC, this part of the retrograde pipeline was virtually invisible so no pre-ATAC comparison can be made. The only time an outside activity could analyze the turn-in performance of a particular unit is during the Supply Management Inspection (SMI).

This data was obtained from the ATAC contractor and is presented with the intention of establishing the value of collecting this type of information on a regular basis. The information presented is not intended to be representative or statistically significant of the activities in the sample population or the Navy in general.

The activities selected for this analysis are the same commands listed in the beginning of this chapter. Because the data had to be retrieved manually from MKE's data base, only 27 of the most recent turn-ins were analyzed. The analysis consisted of comparing the document number of the requisition to the date the carcass reached MKE at the node (current SOW requires the ATAC contractor to routinely record this information for carcass tracking purposes). This is the closest surrogate estimate to the actual in transit time for this leg of the retrograde pipeline, because the date transferred block on the DD 1348-1 is not recorded in any automated data base.

Table XII below provides the summary of data obtained from MKE. The data present wide variations in carcass turn-in performance which is to be expected given the varying missions of the commands in the sample population.

The value of this data becomes apparent when the performance of like commands is compared over a period of time. Changes in an activity's established performance would be easily noted and could be quickly investigated to

TABLE XII

TITLE?

Number of observations for each activity: 27

UIC	MEAN	MEDIAN	STANDARD DEVIATION	RANGE
N00246	10.5	9.0	10.40	0-40
N60200	4.0	2.0	8.77	2-47
N60259	4.8	4.0	4.20	1-17
N60191	3.9	2.0	3.66	2-17
R21295*	11.7	10.0	8.16	2-42
R20807*	73.1	63.0	50.06	9-227
R57082	9.6	6.0	11.32	1-41
V09114	18.9	18.0	6.46	9-43
V32770	35.2	27.0	18.2	14-67
R65918	28.9	23.0	18.2	7-65
N00253	194.7	198.5	45.1	94-237

*Afloat activities

determine the reason for the change. It is clear that this information is worth extracting from MKE's data base. It completes the chain of accountability established in the rest of the ATAC system and is in keeping with the primary objective of the Total System Carcass Tracking, which is to maximize carcass returns and generate statistical reports which highlight the activity's performance as stated in Reference 1.

V. INVENTORY INVESTMENT ANALYSIS

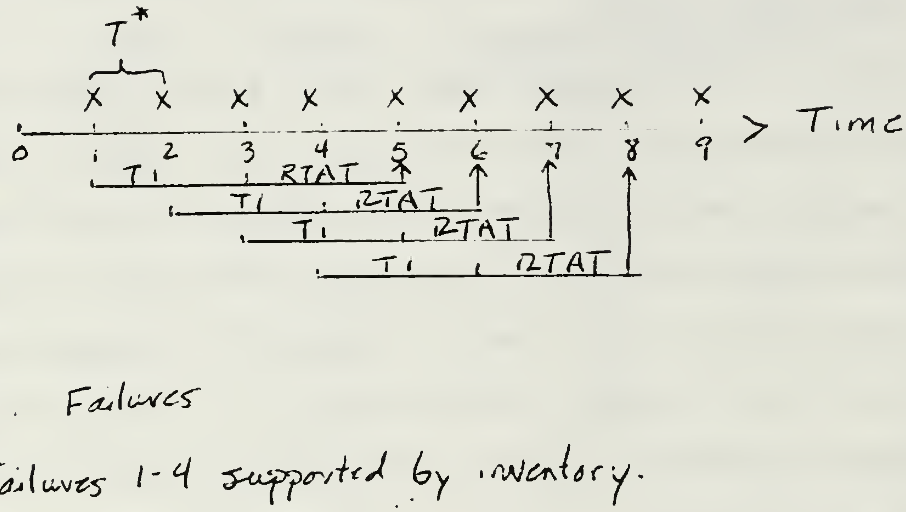
A. INVENTORY MODELING

Chapter IV has established that the retrograde time to return a DLR carcass from end user to the overhaul point has been substantially reduced. This chapter will do some basic inventory modeling to show how such reductions in return time can decrease the level of inventory investment in DLR units at the ICP level. Additionally, the results of an inventory investment analysis performed at the ICP level will be presented.

The following simple scenario is presented to show that reducing retrograde shipping times lowers inventory levels required to fill customer demand. The goal is to fill 100% of all customer demands immediately. In this scenario, demands are assumed to be deterministic with demand times constant (i.e., one demand every T^* units of time; this is similar to Mean Time Between Failure, MTBF). Further assumptions are that T_1 total carcass turn-in time (the time required for a carcass to be shipped from the user and received by the DOP). Carcass regeneration is 100% and Repair Turn Around Time, RTAT, is the time required for the DOP to repair and return the DLR to the storeroom shelf at the user location. To determine Stock Levels, SL, required to support demand, the following equation can be used:

$$SL = (T_1 + RTAT)/T^* .$$

Graphically, the problem looks like [Ref. 10:p. 3-A-8]:



When $T^* = 1$, $T_1 = 2$, and $RTAT = 2$, SL can be computed:

$$SL = (2 + 2)/1 = 4$$

If carcass turn-in time can be reduced to $T_1 = 1$, SL is also reduced:

$$SL = (1 + 2)/1 = 3$$

Heuristically, one knows that if fewer items are sitting in a transportation pipeline, a lower inventory investment can support the same user demand requirements and the above example shows that to be the case.

The UICP subsystem, "Cyclic Levels and Forecasting, D01," contains the algorithms that manage inventory levels of DLRs. It considers demand, carcass return rates, procurement and production leadtimes, carcass repair turnaround times, and carcass survival rates when computing the reorder level and quantity, repair level and quantity, and safety level and reorder points. [Ref. 10:p. 3-23]

This chapter will show three simple examples that will utilize some of the "D01" mathematical models that determine inventory levels for DLRs, and compare any differences in economic order quantity, reorder levels and safety stock levels using differing retrograde times. Since this is an academic exercise, all quantities computed will be unconstrained so that the full impact of changing carcass return times can be examined.

An in-depth explanation of the mathematical models utilized in this chapter can be found in numerous publications and only a cursory description will be included in this thesis. The following assumptions are made with respect to the inventory in the D01 subsystem:

1. A continuous review system is used: the ICP knows inventory levels of DLRs at all times;

2. A steady state environment exists: the key characteristics of DLRs are constant over the immediate future. These include the forecasted means and variances of customer demand, procurement leadtime, production leadtime, repair cycle time and depot level turnaround time, depot repair survival rate and carcass return rate;

3. The unit procurement cost or repair cost of an item is independent of the magnitude of order quantity or repair quantity, and;

4. The cost to hold one unit of stock in the inventory is proportional to the unit cost of the item; [Ref. 10:pp. 3-A-1-2]

The following definitions apply:

Economic order quantity:	EOQ
Reorder Level:	R
Basic Repair Level:	R_2
Basic Repair Quantity:	Q_2
Safety Level:	SL
Acceptable risk of being out of stock:	RISK
Procurement Problem Variable (expected value of number of units required to be on hand to meet all demands not filled by DLR carcass regenerations):	Z
Customer Demand per quarter:	D
Procurement Leadtime in quarters:	L
Inventory holding cost per unit per year (represents the costs of storage, obsolescence and opportunity cost):	I or I_2
Unit Cost:	C
Cost to repair one unit:	C_2
Military Essentiality:	E
Administrative cost of placing an order on procurement plus the manufacturer's production set-up cost:	A
Administrative costs of placing a repair order plus the set-up cost for the repair line:	A_2
Shortage cost per unit ordered:	λ
Requisition frequency per quarter:	F

Quarterly regeneration of ready-for-issue assets from the repair process:	G
Variation in quarterly demand:	σ_D^2
Repair cycle time (includes entire time interval from discovery of defective DLR in equipment at end user location until DLR carcass is repaired and placed back in ready-for-issue status under ICP control; carcass retrograde time in a component):	T
Depot level turnaround time (considered a portion of Repair Cycle Time):	T_2
Max Risk: An ICP parameter that quantifies the acceptable probability of being out of stock for the item being managed. The probability can be converted to standard deviations using the normal distribution tables.	

ICP set parameters are Z, I, I_2, E, A, A_2, max risk and λ. The other parameters are based on historical data computed by application D01. For further details the interested reader should review NAVSUP Publication 553, Inventory Management [Ref. 10].

This thesis will manipulate the variable for repair cycle time (T) and depot level turnaround time (T_2) with different values to show the amount of inventory investment needed to support a given demand.

Example #1

SPCC managed repairable item: 7H 1111-00-222-3333

D, L, and LTD ~ Normally

Maximum risk = .4000 or .25 standard deviations

D = 10	A = $1970
L = 6	A_2 = $ 660

$I = I_2 = .21$ $\lambda = \$800$

$C = \$5000$ $F = 5$

$C_2 = \$\ 500$ $G = 8$

$E = 1$ $\sigma_D^2 = 100$

$T_a = 3$ $T_b = 2$

$T_{2a} = 2$ $T_{2b} = 1$

STEP 1: Determine the Basic Order Quantity, EOQ:

$$EOQ = \sqrt{\frac{8(D-G)A}{IC}} = \sqrt{\frac{8(10-8)1970}{.21(5000)}} = 5.47 \approx 5 \text{ units}$$

STEP 2: Determine the Basic Repair Quantity, Q_2:

$$Q_2 = \sqrt{\frac{8 \min(D,G)A_2}{I_2C_2}} = \sqrt{\frac{8(8)(660)}{.21(500)}} = 20.05 \approx 20 \text{ units}$$

STEP 3: Determine maximum acceptable risk, RISK:

$$C_3 = \left(\frac{G}{D}\right)(C_2) + \left(1 - \frac{G}{D}\right)(C) = .8(500) + .2(5000) = \$1400$$

$$\text{Risk} = \frac{IC_3D}{IC_3D + \lambda FE} = \frac{.21(1400)(10)}{.21(1400)(10)+800(5)(1)} = .4236$$ but max risk = .4 so t = .25

STEP 4: Determine the Procurement Problem Variable, Z:

$$z = (D \times L) - (G \times L) + (G \times T)$$

$$z_A(T_a = 3) = (10 \times 6) - (8 \times 6) + (8 \times 3) = 36$$

$$z_B(T_b = 2) = (10 \times 6) - (8 \times 6) + (8 \times 2) = 28$$

STEP 5: Determine the Basic Reorder Level, R:

$$R = z + t\sigma_D + Q_2$$

$$R_A(T_a = 3) = 36 + (.25)(\sqrt{100}) + 20 = 58.5 \approx 59 \text{ units}$$

$$R_B(T_b = 2) = 28 + (.25)(\sqrt{100}) + 20 = 50.5 \approx 51 \text{ units}$$

STEP 6: Determine the Safety Level, SL:

$$SL = t(\sigma_D) = .25(\sqrt{100}) = 2.5 \approx 3 \text{ units}$$

STEP 7: Determine the Basic Repair Level, R_2:

$$R_2 = (T_2 \times D) + \text{Safety Level}$$

$$R_{2A}(T_{2A} = 2) = (2 \times 10) + 3 = 23 \text{ units}$$

$$R_{2B}(T_{2B} = 1) = (1 \times 10) + 3 = 13 \text{ units}$$

<u>Example #2</u>

SPCC managed repairable item: 7H 1111-00-333-4444

D, L, and LTD $\approx$ Normally

Maximum risk = .4000 or .25 standard deviations

$D = 50$ $\qquad A = \$1970$

$L = 2$ $\qquad A_2 = \$\ 660$

$I = I_2 = .21$ $\qquad \lambda = \$\ 800$

$C = \$500$ $\qquad F = 25$

$C_2 = \$150$ $\qquad G = 40$

$E = 1$ $\qquad \sigma_D^2 = 400$

$T_a = 3$ $\qquad T_b = 2$

$T_{2a} = 2$ $\qquad T_{2b} = 1$

STEP 1: Determine the Basic Order Quantity, EOQ:

$$EOQ = \sqrt{\frac{8(50-40)1970}{.21(500)}} = 38.74 \simeq 39 \text{ units}$$

STEP 2: Determine the Basic Repair Quantity, Q_2:

$$Q_2 = \sqrt{\frac{8(40)660}{.21(150)}} = 81.88 \simeq 82 \text{ units}$$

STEP 3: Determine maximum acceptable risk, RISK:

$$C_3 = (\tfrac{40}{50})(150) + (1 - \tfrac{40}{50})(500) = .8 \times (150) + .2(500) = \$220$$

$$\text{Risk} = \frac{.21(220)(50)}{.21(220)(50) + (800)(25)(1)} = .1035 \quad \text{so} \quad t = 1.26$$

STEP 4: Determine the Procurement Problem Variable, Z:

$$z_A(T_A = 3) = (50 \times 2) - (40 \times 2) + (40 \times 3) = 140 \text{ units}$$

$$z_B(T_B = 2) = (50 \times 2) - (40 \times 2) + (40 \times 2) = 100 \text{ units}$$

STEP 5: Determine the Basic Reorder Level, R:

$$R_A = 140 + (1.26)(\sqrt{400}) + 82 = 247 \text{ units}$$

$$R_B = 100 + 1.26(\sqrt{400}) + 82 = 207 \text{ units}$$

STEP 6: Determine the Safety Level, SL:

$$SL = 1.26(\sqrt{400}) = 25.2 \text{ units} \approx 25 \text{ units}$$

STEP 7: Determine the Basic Repair Level, R_2:

$$R_{2A} = (2 \times 50) + 25 = 125 \text{ units}$$

$$R_{2B} = (1 \times 50) + 25 = 75 \text{ units}$$

<u>Example #3</u>

SPCC managed repairable item: 7H4A 1111-00-555-6666

D, L, and LTD ~ Normally

Maximum risk = .4000 or .25 standard deviations

$D = 4$	$A = \$1970$
$L = 12$	$A_2 = \$\ 550$
$I = I_2 = .21$	$\lambda = \$800$
$C = \$10{,}000$	$F = 4$

$C_2 = \$5000$ $\quad$ $G = 3$

$E = 1$ $\quad$ $\sigma_D^2 = 25$

$T_a = 2$ $\quad$ $T_b = 1$

$T_{2a} = 1$ $\quad$ $T_{2b} = .5$

STEP 1: Determine the Basic Order Quantity, EOQ:

$$EOQ = \sqrt{\frac{8(1)(1970)}{.21(10{,}000)}} = 2.74 \approx 3 \text{ units}$$

STEP 2: Determine the Basic Repair Quantity, Q_2:

$$Q_2 = \sqrt{\frac{8(3)(660)}{.21(5000)}} = 3.88 \approx 4 \text{ units}$$

STEP 3: Determine maximum acceptable risk, RISK:

$$C_3 = \frac{3}{4}(5000) + \frac{1}{4}(10{,}000) = \$6250$$

$$\text{Risk} = \frac{.21(6250)4}{.21(6250)(4)+(800)(4)(1)} = .6213 \text{ but max risk is } .4000 \text{ so } t = .25$$

STEP 4: Determine the Procurement Problem Variable, Z:

$$z_A(T_A = 2) = (4 \times 12) - (3 \times 12) + (3 \times 2) = 18 \text{ units}$$

$$z_B(T_b = 1) = (4 \times 12) - (3 \times 12) + (3 \times 1) = 15 \text{ units}$$

STEP 5: Determine the Basic Reorder Level, R:

$$R_A(T_a = 2) = 18 + .25(\sqrt{25}) + 4 = 23.25 \approx 23 \text{ units}$$

$$R_B(T_b = 1) = 15 + .25(\sqrt{25}) + 4 = 20.25 \approx 20 \text{ units}$$

STEP 6: Determine the Safety Level, SL:

$$SL = .25(\sqrt{25}) = 1.25 \approx 1 \text{ unit}$$

STEP 7: Determine the Basic Repair Level, R_2:

$$R_{2A}(T_{2a} = 1) = (1 \times 4) + 1 = 5 \text{ units}$$

$$R_{2B}(T_{2b} = .5) = (.5 \times 4) + 1 = 3 \text{ units}$$

As the UICP mathematical models show, reducing the carcass return time (T_a to T_b and T_{2a} to T_{2b}) can have a sizable impact on inventory levels required to support a given level of demand in an environment unconstrained by ICP parameters and budgets. In example one, the basic reorder level is reduced from 59 to 51 units and the basic repair level from 23 to 13 units.

Example two is an item with a higher demand per quarter but a much less expensive unit cost. The carcass return times are identical to those manipulated in example one.

The reduction in return times also leads to reductions in the basic reorder level from 247 units to 207 units and the basic repair level from 125 units to 75 units.

Example three is a high unit cost item with low quarterly demand. Additionally, the carcass return times are changed from the previous examples. Even so, a reduction in the basic reorder level from 23 units to 20 units and the basic repair level from 5 to 3 units occurs.

NAVSUP also investigated the effect of reducing RTAT (of which carcass retrograde time is a component) on inventory investment necessary to support a given level of demand. In a 1985 study, Naval Reserve Officers and the Fleet Material Support Office (FMSO) manipulated RTAT parameters via the UICP application "Computation and Research Evaluation System," D56, often shortened to CARES. CARES provides "ICP management with a tool to analyze and evaluate alternative inventory management policies (parameter settings) prior to their implementation in UICP" [Ref. 10:p. 3-56].

The results of the NAVSUP study coincide with the findings of this chapter. A reduction of one week in RTAT would save over $11 million in replenishment buys per year at ASO and would maintain the same levels of fleet support. Reducing RTAT three weeks for SPCC-managed items would save almost $6 million in replenishment buys per year at 1985 prices. In other words, each one day reduction of the repair pipeline saves $1.5 million in inventory investment

for ASO-managed items and almost $300,000 for SPCC items. [Ref. 21]

The purpose of this chapter was to demonstrate that reductions in DLR carcass return times can decrease the level of inventory investment in DLRs at the ICPs. This thesis was able to show such a result from a common sense approach and by using the mathematical models incorporated in the UICP applications used by ASO and SPCC. The NAVSUP sponsored study also showed similar results.

VI. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the findings of previous chapters and describes the conclusions reached based on the statistical analysis and inventory modeling. Finally, recommendations are made for future improvements to ATAC so that it can be used more effectively to manage the movement of DLRs from the end user to the overhaul point.

A. SUMMARY AND CONCLUSIONS

The statistical analysis of the pre-ATAC and post-ATAC populations presented in Chapter IV answered research question one: Does ATAC shorten the shipping time of DLRs from the end user to the overhaul point? Yes; based on the findings of the sample populations of 1800 observations from pre-ATAC timeframe and 4400 observations from post-ATAC timeframe, the implementation of ATAC has decreased the amount of time required to return a DLR carcass from the end user to the TIR/screening activity at five of the seven commands studied. From an aggregate perspective the average turn-in time decrease 10.6 days for this portion of the retrograde pipeline. From a system perspective, a ten day decrease in this leg of the pipeline translates into an equivalent decrease in the total pipeline required to return the carcass to the overhaul point.

Research question two asked: Does ATAC reduce system inventory levels due to fewer parts in the repair pipeline? Chapter V clearly demonstrated that a reduction in the repair pipeline could lead to a decrease in inventory investment levels while still supporting an equivalent level of customer demand by three different methods: a common sense approach, utilizing the mathematical models of the ICPs, and presenting the results of a NAVSUP sponsored study.

There is not, however, a direct correlation between the DLR carcass retrograde times and the level of inventory investment when stock replenishment budgets are compiled at the ICPs. Inventory managers would understandably be reluctant to change UICP inventory model retrograde parameters that would have long term effects on provisioning and inventory support based on short term results of ATAC's performance described in this thesis. Further, budgetary constraints and political mandates are among the number of factors that also influence the level of inventory investments made at the ICP level. What is encouraging and germane to the inventory level question is that the standard deviation of the post-ATAC sample populations showed significant to outstanding improvement in all but one instance. This improvement in the retrograde pipeline performance should warrant inventory modeling reviews to

update pipeline estimates established during the provisioning process.

Research question three asked: How can ATAC be used more effectively from the perspective of the individual ship/type commander? Chapter IV showed that the information that is being gathered by the ATAC contractor can be used to help focus every level of management attention on positive or negative areas of the entire retrograde pipeline. This is in keeping with the stated primary objectives of the Total System Carcass Tracking and the CNO-directed study which is to maximize carcass returns and generate statistical reports which will highlight activity performance [Refs. 1,9].

Another initiative developed by Commander, Naval Surface Force, Pacific Fleet (COMNAVSURFPAC or SURFPAC), would utilize the ATAC program to route electronic modules and printed circuit boards to SIMA San Diego for testing/repair prior to the carcass TIR submission to the ICP and further processeing for repair. One of the problems of the ever increasing complexity of weapon systems is that inexperienced or poorly trained personnel often misidentify the problem when a piece of equipment stops operating correctly. The technician is not concerned with how much it costs to fix the equipment; he just wants to repair it in the fastest way possible. Often the solution to repairing a piece of equipment is to replace "A" condition parts with

parts drawn from stock. This scenario is born out by a recent SIMA San Diego study that found up to 70 percent of the DLR carcasses in "F" condition storage at the supply center were not in fact broken [Ref. 13].

The SURFPAC initiative would screen a specified number of these parts to in fact establish their condition. The number of part to be routed to SIMA would depend on available capacity at SMIA. The ATAC program allows this initiative to work because:

1. The SIMA screening process takes place prior to the carcass being TIRed so that physical ownership of the part does not transfer from the type commander.

2. ATAC system has visibility of the part from the time the carcass reaches the node to the time it goes into screening at the hub.

3. The two hubs have automated their MRIL so flags could be used in empty data fields of the MRIL to alert the screener that this unit should be routed to the SIMA and not processed any further. This function would not interrupt or slow down the screening function. [Ref. 21]

4. The ICPs are exploring using the MKE ATAC data base as an alternative data source in order to improve their carcass tracking effectiveness [Ref. 22]. One of the objectives of accessing the ATAC data base is to reduce the number of administrative follow-ups (BK1s) sent to the end users for material that has not matched in the UICP program within the required timeframe. If this interface between data bases is possible, then the time that it takes the SIMA to conduct the screening would not cause ICPs to initiate the normal administrative follow-ups.

The four main benefits of the SURFPAC initiative are:

1. Type commander funds are not wasted ordering parts that are not needed,

2. SIMA San Diego can be kept fully employed,

3. DOPs are not expending effort on material that does not require repair and,

4. End user activities will actually be able to evaluate the technicians' trouble shooting skills because the SIMA will be able to evaluate repair performance.

B. RECOMMENDATIONS

This portion of the thesis presents the following recommendations to improve the retrograde pipeline management:

1. It is important that the performance of ATAC on the observed retrograde times be monitored at the ICP level on a long term basis so that future inventory investment decisions will be made utilizing actual retrograde pipeline data.

2. One of NAVSUP's initiatives, "Logistics Application of Automated Reading and Marking Symbols" (LOGMARS), is an attempt to provide computer hardware and software to fleet units to:

   a. Improve productivity of storekeeper personnel by automating the receipt and stowage process, and

   b. Improve supply readiness through more accurate inventory (storeroom validity) by reducing human error in receipt and stowage processing and provide better visibility of assets needed onboard. [Ref. 23p. 4]

The LOGMARS initiative provide individual units with a laser scanner that scans bar code labels on material and acts as a data input system to the shipboard inventory management system. As currently designed, the laser scanner can "read" the bar coded shipping document attached to material and download the receipt of that material to the supply department mainframe. LOGMARS will assist shipboard storekeeping personnel in receiving material more accurately

and can also be used to maintain control over the inventory in the storeroom with an accuracy rate heretofore unattainable.

Additionally and germane to a discussion of ATAC improvements, fleet units equipped with LOGMARS systems receive updated document printers that will print bar codes for material being offloaded for disposal or transfer. This is an important capability for many reasons. Mr. Estep, the NAVSUP ATAC program manager has said that both pre-ATAC and post-ATAC DLR carcass turn-in organizations have had problems with missing or garbled turn-in documentation. The current system has the end user preparing a typed turn-in document for a specific DLR carcass and attaching the document to the carcass for shipment to the ATAC hub. At the hub, the ATAC contractor takes the turn-in document and prepares a bar code label that includes the end user document number and the carcass stock number. The bar code label is attached to the carcass and is sent through the hub for screening and TIR submission. Presently at both hubs, the TIR submission requires the terminal operator to read the original typed turn-in document prepared by the end user and then manually keypunch the pertinent data into the terminal. In this sequence of events there are three opportunities for erroneously key punching in the wrong data. These opportunities for error are: first, the storekeeping personnel at the end user can mistype the turn-

in document. Second, the ATAC contractor can mistype the bar code label, and finally, the TIR terminal operator can keypunch incorrect data to the ICP. Regardless of who makes the mistake, the end result is a mismatch at the ICP resulting in an increase in administrative follow-up and potential loss of OPTAR funds due to a carcass charge.

LOGMARS bar code capability should be compatible with the bar code scanners used at the ATAC hubs. This will place the responsibility of providing correct turn-in data on the end user and will eliminate further possibility of incorrect data submission by either the ATAC contractor or the TIR terminal operator. Since the end user ultimately pays the bill for carcass losses, he should be held responsible for preparing correct turn-in documentation. Also, the adoption of this recommendation should simplify the reconciliation of any mismatches that do occur. Further, the elimination of the requirement for the ATAC contractor to perform bar coding of turn-in documentation should result in savings on subsequent contracts due to reductions in performance requirements.

3. SURFPAC's initiative to route certain DLR carcasses to SIMA San Diego for screening and repair should be adopted for the entire surface forces. This increase in repair parts support would bring the surface forces up to par with the aviation and submarine forces.

4. The timeframe from the preparation of the turn-in document to the time the carcass reaches the node needs to be monitored on a continual basis by the type commander to insure that activities are turning in material in a timely fashion.

This study has found that the ATAC program is an effective element in decreasing retrograde time, potentially decreasing the level of inventory investment necessary to support a give level of demand, and increasing carcass traceability and accountability. ATAC's strongest asset may be its adaptability. As the Navy's needs change, the ATAC program can respond more quickly because the Navy is not encumbered by the fixed overhead of a turn-in organization. If the present contractor can not be responsive to the emergent needs then the Navy can solicit new contractors. The ATAC program under the current contractor effectively addresses the critical success factors of shipment tracing capability, time-in-transit, and adaptability to specific needs. Further, the basic ATAC system has significant potential for growth and integration with other Navy inventory programs.

APPENDIX A

STATISTICAL ANALYSIS

A. PRE-ATAC

UIC: V09114
Variable: BC1 Days
Observations: 53
Minimum: 0 Maximum: 173
Range: 173 Median: 10
Mean: 15.887 Standard Error: 3.489
Variance: 645.064
Standard Deviation: 25.398
Coefficient of Variation: 159.869

UIC: V09114
Variable: BC2 Days
Observations: 53
Minimum: 1 Maximum: 88
Range: 87 Median: 13
Mean: 15.491 Standard Error: 1.698
Variance: 152.793
Standard Deviation: 12.261
Coefficient of Variation: 79.797

UIC: N60200
Variable: BC1 Days
Observations: 358
Minimum: 0 Maximum: 398
Range: 398 Median: 4.5
Mean: 8.877 Standard Error: 1.380
Variance: 681.436
Standard Deviation: 26.104
Coefficient of Variation: 294.064

UIC: N60200
Variable: BC2 Days
Observations: 358
Minimum: 1 Maximum: 711
Range: 710 Median: 12
Mean: 15.774 Standard Error: 2.066
Variance: 1527.979
Standard Deviation: 39.089
Coefficient of Variation: 247.813

UIC: R21295
Variable: BC1 Days
Observations: 84
Minimum: 2 | Maximum: 525
Range: 523 | Median: 29.5
Mean: 61.893 | Standard Error: 10.27
Variance: 8869.711
Standard Deviation: 94.179
Coefficient of Variation: 152.165

UIC: R20807
Variable: BC1 Days
Observations: 55
Minimum: 7 | Maximum: 433
Range: 426 | Median: 38
Mean: 75.127 | Standard Error: 11.018
Variance: 6676.891
Standard Deviation: 81.712
Coefficient of Variation: 108.765

UIC: R65918
Variable: BC1 Days
Observations: 205
Minimum: 7 | Maximum: 445
Range: 438 | Median: 28
Mean: 51.088 | Standard Error: 4.221
Variance: 3652.610
Standard Deviation: 60.437
Coefficient of Variation: 118.300

UIC: V32770
Variable: BC1 Days
Observations: 12
Minimum: 8 | Maximum: 391
Range: 383 | Median: 40.500
Mean: 75 | Standard Error: 30.510
Variance: 11170.364
Standard Deviation: 105.690
Coefficient of Variation: 140.920

UIC: N00253
Variable: BC1 Days
Observations: 1009
Minimum: 0 | Maximum: 387
Range: 387 | Median: 18
Mean: 36.859 | Standard Error: 1.412
Variance:2012.113
Standard Deviation: 44.857
Coefficient of Variation: 121.697

B POST-ATAC

UIC: V09114
Variable: BC1 Days
Observations: 74
Minimum: 0 Maximum: 267
Range: 267 Median: 11.5
Mean: 20.243 Standard Error: 3.998
Variance: 1183.036
Standard Deviation: 34.395
Coefficient of Variation: 169.910

UIC: V09114
Variable: BC2 Days
Observations: 74
Minimum: 0 Maximum: 64
Range: 64 Median: 18
Mean: 19.973 Standard Error: 1.432
Variance: 151.670
Standard Deviation: 12.315
Coefficient of Variation: 61.661

UIC: N60200
Variable: BC1 Days
Observations: 1850
Minimum: 5 Maximum: 244
Range: 239 Median: 19
Mean: 27.485 Standard Error: .554
Variance: 568.158
Standard Deviation: 23.836
Coefficient of Variation: 86.723

UIC: N60200
Variable: BC2 Days
Observations: 1850
Minimum: 1 Maximum: 241
Range: 240 Median: 11
Mean: 13.582 Standard Error: .277
Variance: 141,913
Standard Deviation: 11.913
Coefficient of Variation: 87.709

UIC: R21295
Variable: BC1 Days
Observations: 177
Minimum: 2 Maximum: 311
Range: 309 Median: 32
Mean: 40.525 Standard Error: 3.549
Variance: 2229.842
Standard Deviation: 47.221
Coefficient of Variation: 116.522

UIC: R20807

Variable: BC1 Days
Observations: 62
Minimum: 7 Maximum: 186
Range: 179 Median: 25.5
Mean: 31.177 Standard Error: 3.637
Variance: 820.181
Standard Deviation: 28.639
Coefficient of Variation: 91.858

UIC: R65918

Variable: BC1 Days
Observations: 259
Minimum: 10 Maximum: 226
Range: 216 Median: 31
Mean: 44.413 Standard Error: 2.501
Variance: 1619.623
Standard Deviation: 40.245
Coefficient of Variation: 90.614

UIC: V32770

Variable: BC1 Days
Observations: 40
Minimum: 15 Maximum: 107
Range: 92 Median: 33.5
Mean: 38.125 Standard Error: 3.370
Variance: 454.317
Standard Deviation: 21.315
Coefficient of Variation: 55.907

UIC: N00253

Variable: BC1 Days
Observations: 1938
Minimum: 0 Maximum: 433
Range: 433 Median: 9
Mean: 16.632 Standard Error: .614
Variance: 730.216
Standard Deviation: 27.023
Coefficient of Variation: 162.477

APPENDIX B

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ASO	Aviation Supply Office
ATAC	Advance Traceability and Control
CNO	Chief of Naval Operations
DDF	Due in Due out File
DLA	Defense Logistics Agency
DLR	Depot Level Repairable
DMISA	Depot Maintenance Interservice Support Agreement
DOD	Department of Defense
DOP	Designated Overhaul Point
DSP	Designated Support Point
FIRM	Fleet Intensified Repair Management
FMSO	Fleet Material Support Office
FRAA	Fleet Repairables Assistance Agent
GBL	Government Bill of Lading
GSA	General Services Agency
ICP	Inventory Control Point
IMA	Intermediate Maintenance Activity
MCC	Material Condition Code
MDF	Master Data File
MILSTRIP	Military Standard Requisition & Management Information System
MOD	Maintenance Overhaul Designator
MOE	Measure of Effectiveness

MPD	Movement Priority Designator
MRIL	Master Repairable Item List
MTIS	Material Turned Into Shore
NARF	Navy Air Rework Facility
NSC	Naval Supply Center
NSD	Naval Supply Depot
POD	Proof Of Delivery
POS	Proof Of Shipment
PPF	Planned Program Requirements File
RFI	Ready For Issue
ROD	Report Of Discrepancy
RTAT	Repair Turn Around Time
SM&R	Source Maintenance & Recoverability
SOW	Statement of Work
SPCC	Ships Parts Control Center
THF	Transaction History File
TIR	Transaction Item Reporting
UICP	Uniform Inventory Control Point
UADPS	Uniform Automated Data Process System
USN	United States Navy
WISSA	Wholesale Interservice Supply Support Agreement

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